oct. 13th 1854.

1854-10-13

Lecture — on the Theory of the Forces of Nature.

The Study of Life lies at the foundation of all Physiology; — and therefore of Medicine itself. and To obtain a comprehensive idea of life, — we must study it not only in its highest forms, — but in all its varieties; not only in man, — but in the animals; & not only in animals, — but even in its simplest manifestation, — in the plant.

And, — as life is only one of Nature's many & kindred activities, we ~~must~~ cannot obtain any idea of its nature, or of its Laws, even, — without comparison with the other forces of Nature; with which it is in so close & constant relation.

It is with this view, — as well as, because of their incessant influence upon the state of the body, in health & disease, — that ~~I propose~~ ~~to give~~ some time ~~in the body of the Course~~ may with propriety be given in a Course upon Physiological subjects

— over —

an analysis of the essential laws and nature of ~~that of~~ these forces, or causes of action.

~~They are, — Gravitation~~

We may thus be led, by a gradual ascent, to a rational understanding of such facts as we know, which bear upon the greatest problem of nature — that of Life.

On

Look at them:

Heat, — we cannot live without heat!

& Light, — no plant can grow without light, — and what would our food be without the vegetable world, — upon which all the animal world depends?

& Electricity, & Galvanism show their phenomena in our bodies, — with we know not yet how great an importance, — & even Magnetism has, — in muscle-fibre-cells for instance, many instructive analogies,

& the Excito-Motor Force, & Vital Impulse itself, — are so indispensably a part of Dynamic Physiology, that we need only to mention now their relation to the other forces.

Omit — Omit at present

4

(~~Study~~) Comparison, if we turn to the older works of natural science, somewhat painfully,

In this ~~Synopsis~~, we are met, at the very outset, by ~~that~~ ambiguities in the expression of Natures ~~activities~~ agencies, which renders Natural Philosophy, while in many respects exact, — in others a mere leaner upon and borrower from Theory and Hypothesis. I allude to the Doctrine of the Forces; once denominated Imponderables, or imponderable matters. The consideration of these is inseparable from every scheme of nature, inanimate or animate; — and must thus form a basic part of Physiology itself. From this importance of the subject, — and the instructive steps of induction by which it enables us to approach the mysteries of ~~life and~~ Biology, — I have thought it proper not altogether to pass it by, — or to take for granted a familiarity with it in your previous Studies. Yet an unwillingness to detain you with matters of a somewhat speculative nature, will prevent me from giving it much attention in the body of our course. Allow me, then, ~~with patience~~, — ~~in place of a more rhetorical exercitation~~, — to ~~speak of these the~~

(Oct. 13th 54.)

† I may ~~mention~~, that in this School, for the first time in this city — and probably in the Country, — ~~one year ago~~, — ~~a year ago~~ Dec. 1853. was the doctrine clearly inculcated, which I am about to assert upon this subject; since which time it has been ~~gradually~~ rapidly accumulating authority & influence, & is now decisively taught in the University at least, where, in part only, it had been previously accepted by Professor Jackson

---

*If ~~[illegible]~~ those of you who are impatient for facts should consider it too speculative an inquiry, I beg to repeat, that so much the more of theory will be spared from the after lectures of the course. View it but as an intellectual recreation, or exercise, if you will, — ~~it~~ the subject still has a certain interest, if not a positive value.

~~present time; — and~~ to give you a~~n~~ brief outline of what I have been led to adopt, — by no idle reflection, — as ~~the~~ Theory of the Forces. +

Besides the attractions of Gravitation, ~~[illegible]~~ & Chemical Affinity, — (you ~~may be~~ are no doubt generally aware, that) the physical forces or once-called imponderable materials are, — Heat, Light, Electricity, Galvanism, & Magnetism; to ~~which~~ are by some added, also, Life or organic force, — & the Excito-motor force of the musculo-nervous system of animals.

Referring ~~[illegible]~~ to another course for
(Anticipating now) the review of phenomena ascribed to these recondite though extensive and ever powerful causes of action in Nature, — we may spend a few moments, (perhaps not entirely without profit~~ably~~), — in observing some of their mutual relations, — connections and inter-actions, — so as to ascertain, if possible, whether a harmonious scheme of causation, — a consistent theory, may be so developed as to embrace them all. *

There has been a strong disposition for many years, — in the minds of those who treat of

these subjects, — to assimilate all the physical causes or forces under one head. Perhaps this wish and attempt may be ascribed to what is no new passion of the philosophic understanding, — the root of alchemy, — a love of simplification; — a desire to unite under one category as great a variety of nature's actions as possible. But there would seem to be much plausiblity in this hypothesis; much inducement to yield to it as a speculation at least: and, beginning the investigation with a preconceived aversion to its now most bruited conclusion, — I have ~~already~~ been led on to urge it, even, in some respects,+ — more boldly than those from whose reasonings it was borrowed. The hypothesis, as usually ~~Grove, Faraday, — Carpenter and others~~ sustained ~~it~~, — advocates the existence of a subtle and universal ethereal fluid, diffused throughout all space, & penetrating the substance of the densest solids; for which I have ventured to suggest, from reasons of obvious con-

-venience, the name of Etherene. The vibrations of this universal and most subtle fluid, 700 000 times lighter than air, — and proved to be ponderable only by a slight retardation of the velocity of comets, — the vibrations of this etherene are supposed to cause not only light, — whose rays are its waves, — but, — in oscillations of less rapidity, heat, — and, in a farther modification, electricity, — in all its various phases of frictional excitement, — voltaic currents and magnetic polarity.

But, having once embarked upon the stream of reasoning which suggests and seems to uphold this theory, in regard to light especially; — why should we shrink from ~~all~~ farther conclusions toward which it would urge us? ~~And~~ Why, — having learned to appreciate the almost infinite diversity of effects ascribable to vibrations, and polarity of particles of this subtle fluid, ~~[illegible]~~ should we neglect also to appreciate the possibility of other matter being subject to similar ~~polarities~~, motions, vibrations and tendencies, — and hesitate to recognize the

* Having not, at the time when this Lecture was written, read *Grove*, — I did not know that the idea of motion and polarization of the particles of "ordinary matter", was fully realized by him: He prefers, in fact — to dispense with the hypothesis of the "ether" altogether: *this* being, I think, the only fallacy in his treatise.

vide *Grove on the Correlation of the Phys. Forces*,
2nd edition — 1850. —

full *import* of these vibrations, *not only* in the universal ether, or atherene, but in the particles of *all matter*? Considering then that oscillations of the one ethereal fluid alone are *insufficient* to account for all the phenomena called those of the Physical forces, — we yet hold that we have quite enough to account for them all, in the *kindred* and *associated* vibrations of atherene *and of the particles of all matter*, * in which these phenomena are observed. We would thus evolve a theory, (or hypothesis), in which all the series of physical phenomena are embodied under the one great category of *molecular motion*. Molecular motion, tendency and polarity, ~~with~~ or under attraction, will, it seems to me, - designate and comprise all those actions of nature, to which the several terms of Forces or Imponderables have been applied. You know perfectly well ~~undoubtedly~~ what is meant by molecules; you are no doubt familiar with the atomic theory, which holds all bodies to be composed of definite particles or molecules, - of a

minuteness beyond the reach of our mechanical or microscopic powers of subdivision, — but yet ascertained by the facts of chemical combination. You know also that the particles of matter are shewn not to be absolutely in contact with each other, — by the fact that the densest substances are always capable, to some degree, of compression. It is easy, therefore, to conceive of vibrations in bodies quite too subtle to be perceived *as such* by our senses, — and yet which may be made evident, ~~by the~~ through the phenomena produced by them.

To begin at the commencement of the series. The *inertia* of matter is an important item in natural philosophy. It is its *simplest property*; by virtue of which all matter will forever stay at rest, — unless some internal or external force propel it, by mass or in particles: and by virtue of which, also, when it *has been* propelled into a certain kind of movement, it tends, by what is called *impetus*, to continue in that movement until arrested by a more powerful cause. Impetus is the inertia of matter in motion. ~~Inertia is to force~~

*Grove calls friction "arrested motion". He remarks the fact also — that friction of *homogeneous* substances causes heat; of *heterogeneous*, — electricity in addition.

~~what dark~~

~~and nega~~

particles, –

of a mass

~~and without~~

kind of m

can be

and percu

friction and

of the molec

-cerned, – by

of contiguou

forward ~~in t~~

condition of

is, inequality

once to an

of the most

VIBRATION.— There is no point in which the science of the last fifty years has made more astonishing advances and discoveries than in regard to Vibration.

Sound, for example, is nothing but this, and the tympanum of the ear would appear simply to be an instrument capable of being set in corresponding motion, and thus registering to the brain the number of these undulations in a second, varying as they do from thirty-two in a second to twenty-four thousand in the same time. Sound is then simply a certain wave-like motion communicated to the air. In a chord, these vibrations strike together; in a discord, they strike irregularly and between each other.

Light, it is now also pretty well demonstrated, is nothing but a series of vibrations of a more subtle ether, and the eye only an instrument for receiving and registering them. There must be, it would seem, throughout all space that is certainly between us and the most distant fixed star, an exceedingly subtle fluid, with none of the grossness of our atmospheric air, but capable o being set in undulatory motions of extreme rapidity, and these so affect the nerves of the retina as to cause the sensation of light. 458 followed by twelve ciphers, thus, 458,000,000,000,000, gives the number of vibrations per second which produce the sensation on the eye of a single ray of *red* light. This is the smallest number of any kind of light; a violet ray is 727,000,000,000,000. Such is the undulatory theory now generally received as the *least* difficult to conceive.

Electricity, like light, used to be considered as an extremely rare and subtle fluid, moving with a rapidity about as great as light. Now, however, many of its effects are to be considered as most easily explained by a theory of undulations of some extremely subtle medium. In fermentation also, the changes produced seem all attributable to a certain vibratory motion, communicated in some way by light and heat to the fermenting body, water probably serving as the medium of communication between the particles.

In vegetable life, it would seem as if light and electricity, not as fluids, but as forces, are the means of developing all growth. A single ray of yellow light beats against the bulb of a plant, or the seed of a tree, at the inconceivable rate of 535,000,000 times in the millionth part of a second, and this acting upon the germ, awakens within it some corresponding motion, and is thus the force that in the course of many years gives growth to the tallest tree now in the forest, and weighing tons of matter extracted from the atmosphere.

Animal life exhibits many analogies to vegetable, and the line between them is not easily drawn. All seems to be caused by certain undulatory movements, waves of light and electricity acting upon certain monads and exciting them to motion, and indeed to become in turn sources of motion, at first involuntary, and afterwards voluntary. All vegetable and animal life is thus the work of unseen, unknown, moving forces such as those which we call light or electricity, or what we please. But all amounts to this, that beyond any traces of matter, there are traces of a something beyond matter acting upon it, moving it and shaping it in certain forms, all expressive of order, will, intelligence and harmonious design, from the frost upon the window pane to the leaves of plants and their colors; and from these again to the hand of man, and even the instincts and intuition with which he is endowed. All creation thus becomes visibly the work of a *moving power*, inconceivably vast, but carrying out harmonious and settled designs through innumerable ages. In a word, as Agassiz has said, it is impossible to understand the visible creation except by regarding it as the expression of a thought of God, the embodiment of a design of his.

If we now begin at the other end, and instead of looking from inert matter inward to design, we look from design outward to its effects on matter, what do we find? Begin with *the will of man*, that great moving power of civilization, that free choice, the immateriality of which is no less a matter of personal consciousness to each one of us, than its power over matter. This it is which makes us conscious *causes*, agents and not merely passive recipients. We resolve to lift an arm, and we do lift it; to set down a foot, and we set it down. But where lies the point of contact and connection between the spontaneous thought, the immaterial will and the hand or the foot? Who shall answer this? Motion is the nearest point of connection to which we can trace it all. That hand may set in motion a foreseen train of causes that shall shake the solid earth for miles, destroy navies, and move trains of cars, or tons of coal. Or it may send messages thousands of miles. All the other links in this chain are easily traced, but yet there is one link, that which unites the *will* with the *first motion*, mind with matter, who shall trace? We are all conscious of will, and conscious of motion, but how does the one produce the other? A message we shall be told is in some way sent along the nerves, perhaps by electricity, and this moves the muscles; but by the term electricity we only mean one particular kind of vibratory motion, with which we are familiar. Our inquiry now is, *what sets that motion moving?* We cannot tell. All we can say is that at the first point at which we find our thoughts, and conscious immaterial wills producing sensible effects on matter, there also we find the evidences of a higher thought, a more amazing, harmonious, complete and conscious will, acting upon the whole universe, from the most distant star, the undulations of whose light reach us only after travelling for millions of years, to the sound of the little insect, the vibrations of whose wings are not less than 12,000 in a second. Vibration seems to be the nearest point of junction between mind and matter which we can trace in all creation. We can certainly approach as near to the direct perception of a personal Deity presiding over creation, as of a personal will in any other being out of ourselves.

~~rect opposite~~

asses, – or in

e of place

~~d to other bodies~~,

haps the simplest

ass and particles

e call friction,

scrutinized,

a disturbance

the masses con-

– different parts

then, – looking

to the essential

c currents, – which

– we leap at

implest and one

movements.

VARIETIES.

A GOOD STORY is told by the New Haven Re-
ister of "Bishop," who was sent down to New
ork with one of his patent fly-trap machines,
ich makes the fly catch himself by a revol-
ng cylinder. A butcher was very desirous he
ould set it agoing in his shop, and in the course
half an hour something less than a peck of
s had been "hived." The butcher was
sed, but concluded, as his flies were "all
ed," he "didn't want the machine,"
ry well," said Bishop; "I'm a Yankee,
won't take any advantage of you by carry-
ff your flies," and drawing the slide, he
ted the whole swarm about the butcher's
and beat a retreat under cover of a little the
st buzzing ever heard in that vicinity.

UOR STATISTICS IN THE BRITISH ISLES.—
onsumption of ardent spirits continues to be
arge, both in England, Scotland and Ireland,
2, the population being 15 500,000, the con-
tion was exactly one gallon per head. In 1851,
population being 27,452,000, the consumption
one gallon and one twenty-seventh of a gal-
a head. In England merely, at the last census
51, the consumption had fallen off in the ratio
,000,000 of gallons to 18,000,000 of people. In
and, in 1802, the consumption was about one
n and a third per head; in 1851, about three
s per head. In Ireland, in 1802, the con-
ion was a gallon each person, and in 1836,
allons each. Scotland, therefore, bears off
p so far as hard drinking goes.

ATION OF METHODISTS.—The mission to
iendly Islands has been so successful that
tion is a nation of Methodists, and the
population, from the King (who is a "lo-
acher") down to his meanest subject, at-
the Wesleyan ministry. These islands
etimes go by the name of Tonga. They con-
of a hundred and fifty, and lie in the Pacific
n, between latitude 13 degrees and 25 degrees
th, and longitude 172 degrees west and 177
st. They were discovered by the navigator
asman in 1643, but received their collective
ame of Friendly Islands from Captain James
ook.

U. S. PATENT OFFICE.—The following patents
re issued to Pennsylvanians for the week end-
g 19th instant. To Thos. Brownfield, of
orge's township, Pa., for improvement in
eels for carriages; Geo. Fetter, of Philadel-
ia, Pa., and John S. McClintock, of Liberty-
lle, Illinois, for improvement in coupling pipes;
m. H. King, of Phila. Pa., assignor to himself
d Isaac Hyneman, of same place, for machines
r sweeping gutters; John S. Shepler, of Bea-
er, Pa., for washing machine.

SANITARY MEASURES.—In London, the In-
ctors of Nuisances are pretty thorough in
r examinations. It appears that in one week
recently accomplished the following ser-
:—Seventy-nine nuisances complained of
een removed; 985 houses had been placed
er treatment" for filthiness, 416 cellars had
examined, and 87 lodging houses had been
ted upon. Similar promptness in this city
be very gratifying to the community in
l.

OCRATIC NOMINATIONS.—rawford Co.—
bly, Wm. McArthur and Joseph Patton,
emmend J. Porter Brawley, for Congress.
ong Co.—Congress, Alexander McKinney,
tmoreland; Senate, Joseph Clark; As-
John K. Calhoun and R. Nicholson.
Co.—Assembly, G. Nelson Smith. Ad-
—Congress, Wilson Reilly; Senate,
. Brewer; Assembly, Isaac Robinson.
and Co.—Congress, Dr. John J. Ahl;
, James Anderson and Wm. Harper.

-WHEELED PHÆTON.—There has been
Columbus, Ohio, for some weeks past,
heeled phæton, which is said to work
y, and it is thought will introduce a
of vehicles into use. It obviates the
es now experienced in getting into our
four-wheeled vehicles, and in turning
The front wheel is so arranged as to run
, and there is less friction and conse-
less resistance to draught.

AR-WEST" PACKET LINE.—Some gen-
of St. Joseph, Mo., have contracted for
ding of a steamboat at Louisville, Ky., to
s a packet between St. Joseph and Coun-
fs, Iowa, to be ready for the opening of
s next spring. This line is demanded by
owing business of that region, which will
ll further increased by the completion of
annibal and St. Joseph railroad.

BE DETECTED.—On the recent trial of Dr.
r, in England, for poisoning Mr. Cook,
r which he has been executed, Dr. Here-
the well known chemist, stated that the
ce of strychnine could always be detected,
ave as an important proof that if he put ten
of the poison into seventy thousand grains
er, he could detect its presence in a tenth
a grain of that water.

THERN EDUCATION.—Bishop Polk, of Loui-
, has addressed a circular to the Bishops of
essee, Georgia, Alabama, Arkansas, Texas,
ssippi, Florida, and the Carolinas, on the
sity of organizing a system of Southern
tion, and building up Southern religious
tions, as part of a general system of de-
of which the South is daily growing in
eed.

NTELLIGENT ECHO.—What must be done
uct a newspaper right?—Write. What is
for a farmer to assist him?—System.
uld give a blind man the greatest de-
ight. What's the best counsel given
e of the Peace?—Peace. Who commit
st abominations?—Nations. What cry
atest terrifier?—Fire.

DAY'S WORK.—On Thursday, be-
. M. and 10 P. M., one hundred and
ags of grain were taken into Gibbs,
Co.'s warehouse, in Chicago, Illinois,
ut of their four elevators, besides that
teams, resting an hour for dinner, and
r supper. The grain amounted to
bushels.

AS PREACHING."—The New York
n laments that so many churchmen are
rful givers," but give grudgingly or
o church charities, and attributes the
is delinquency to extravagance in fe-
ry, the expenditure for which, the
n avers, are as $1000 to $50.

K TRADE.—There are three hundred
e publishers in the United States; two
ooksellers; fifteen thousand printers,
thousand five hundred bookbinders.
er of new books issued in 1853, is said

* Some calls frictio
the fact also — ~~that~~ fri
heat ; of heterogeneous

marks
s causes

~~what darkness is to light~~ ; ~~its direct opposite and negation~~.

Motion, ~~then,~~ is either in masses,- or in particles,- or in both.

Next to the mere change of place of a mass of matter, without ~~regard to other bodies, and without~~ contact with ~~them~~ other bodies,- perhaps the simplest kind of movement in which a mass and particles can be involved, is in what we call *friction*, and *percussion*. Philosophically scrutinized, friction and percussion involve a *disturbance of the molecular equilibrium* of the masses concerned,- by *unequal action upon different parts of contiguous surfaces.* * Already, then,- looking forward ~~in the rank of occurrence~~ to the essential condition of the developement of *voltaic currents*,- which is, inequality of molecular action,- we leap at once to an analogy between the simplest and one of the most complex of physical movements.

To go on, then, Friction and percussion, which we have defined to be kinds of motion affecting unequally the condition of surfaces, — cause *heat*. Every savage knows this, when he seeks to light his fire by rubbing briskly together two pieces of dry wood. Friction and percussion also cause *waves of sound*. These vibrations we can sometimes see, and feel with our sense of touch. Rudely made, these waves constitute *noise*, when the undulations are unequal, — and follow each other in no measured succession. The vibrations of sonorous bodies can easily be recognized as of two sorts, — those of *inflection*, as they are called, or of elevation & depression, — and those of expancion and condensation. The *analogy* of this fact is to be recollected again, — in looking at the contrast between the phenomena of statical electricity, and those of the currents of the battery. Vibrations may be, in fact, in any oscillating body, either in any *one*, or in *all* directions; as light, though always under the same acknowledged undulatory

* Principles of Human Physiology, p. 357-8, &c.

kindred of sound to light, — and to all other vibrations, — most ethereal, — that thrill matter, and bring it into subtle contact and connection with mind.

To proceed with the series. We have seen that motion causes motion; — and that friction and percussion cause heat, and waves of sound. They also produce ~~as you know~~, — ~~statical~~ electrical excitement; that which makes the charge of the machine. To use the words of Dr Carpenter, ~~who does not suggest~~ ~~clearly~~ ~~the exact theory under discussion~~, * ~~although he affords a material for it~~, — "When Motion is retarded by friction, Heat is generated; — with Electricity in addition whenever the rubbing surfaces are other than homogeneous; so, he continues when Heat is caused to vaporize water, — it no longer manifests itself as Heat, — but in the form of mechanical power which produces Motion." In Liebig's treatise on the Motion of the Animal Fluids, somewhat similar views are expressed.

Friction, percussion, torsion, and rotation, will also under certain circumstances produce Magnetism.

And, farther, — Heat causes Light: flame is only ~~some~~ a solid, liquid, or gaseous matter, chiefly solid particles in a gas, — heated to what is called the luminous point. Heat also causes and promotes chemical action; whether that action be to the formation or the decomposition of compounds: heat causes and promotes chemical action; a kind of motion. Heat causes also currents of voltaic electricity; as ~~you remember~~ in the well-known Thermo-electric battery, — and as so beautifully applied by Biot & Barlow? Ampère to the explanation of the magnetism of the earth. Preferring to change our terms in connection with the present phase of the inquiry, — we ~~will~~ may say, that, besides light and chemical action, — heat may be made to cause electric or galvanic polarization, or polarity.

Light, then, also causes chemical action; as in the Daguerreotype, and in the formation of chlorophylle and other coloring principles, in the sundeveloped growth of plants: and light has also been shewn by Faraday to be capable of inducing,

* vide Erore

electric excitement or movement.*

Chemical action causes *heat* and *light*, - as in combustion, - which is nothg but chemical action; - and, also, *voltaic electricity*; being the ordinary and familiar source of this in the battery; and chemical action, - as already incidentally cited, will cause other *secondary* chemical action, - as in fermentation, and putrefaction, and in the action of contagious virus upon the animal economy. Chemical action is also a most essential part of the process of developement of *organized forms* under the *life-force*, which force cannot in fact exert its prerogative without having Chemical affinity for its servant and instrument.

Electricity causes *heat*, *light*, *magnetism*, - and chemical action; - and stimulates, or generates and sustains *motor-force* in living beings. You may be aware how early, - how often, - and

with what naturalness of suggestion the identity of electricity with the nervous force or fluid has been imagined. And the discoverer of the Acarus Crossii,— that famous insect which rejoiced in a medium of ~~sulphuric acid~~ metallic solution and awoke to existence under the current of a galvanic battery,— was naturally confident of the identity of electricity with *life*. Again,— the essential importance of the electric relation in the Chemical union of elements,— as evinced in what is called their electrolytic decomposition,— by the Battery,— gave rise with the same plausibility to the dogma,— that electricity and chemical affinity were one.

The intimate correlation between frictional electricity, (of the machine) and that of the voltaic current, is evident in many ways. For instance, a large battery of Leyden Jars well charged, will produce electrolytic decomposition by its discharge; the common electric spark will cause

the union of various gases, when only of moderate power. It is even asserted that electromagnetism may be developed in a similar way.

Conversely, also, a voltaic battery of a large number of cells or plates, so as to give great intensity, — will produce the characteristic effect of the machine electricity, — the attraction and repulsion of light bodies.

Magnets, — by being made to approach and recede from their keepers, will cause currents of electricity.

More doubt appears to exist as to the nature and nearness of the relation in which the life-force, and the dynamic or excito-motor force of animals stand to the forces of inorganic nature. But, by a step-by-step induction, — it seems to me that the difference is chiefly one of degree, — added to that induced by the peculiarity and complication of the *material* and the forms in which they act. In Faber's wonderful speaking automaton, *Illustrate "complex motion," also, — by the experiment with a marble or a napkin ring, under the finger, — made to go and return again; or the hoop thrown into the air similarly; or the weapon of certain savages in Australia ~~Western Africa (or S. America?)~~, — which is shaped so as, — when thrown — to go through quite a complex series of curves before it reaches the point aimed at.

for an illustration, the same mechanical powers are employed, to a great extent, as in the common accordeon; but the material, its forms and arrangements are different, — more complex, higher in design and action.* There is no doubt of the great dependence of the life-force on the physical forces, — particularly on heat, — chemical affinity, — and endosmose, — for its ~~[illegible]~~ developement. Look for instance at the mummy wheat of Egypt — locked up in old tombs and dried for perhaps ~~5000~~ 3000 years. The latent life of its desiccated grains is at once revived by moisture and heat, — and the before powerless vitality ~~principle~~ resumes its function, giving birth to root, blade, flower and seed. Some species of living beings are asserted by Spallanzani to be capable, by alternate supply and deprivation of moisture and heat, — of life and its suspension by turns, — at intervals of 6 or 7 years in each case.

It is needless to discuss ~~now~~ and here the

theories with regard to life and its nature,—or the propriety of the different terms used to designate its cause or essence; as the ψυχη of Aristotle,—Harvey's animating principle,—the organic agent of Prout,—~~and~~ the organic force of Müller. That life is something,—a something <u>positive</u>, not negative or constructive,—all recognize; none more fully, than the unimaginative and accurate John Hunter; who ended ~~the~~ investigation, and began his theory,—with the clear dictum,—that "<u>Mere composition of matter does not give life</u>". Bichat defined life to be,—"the aggregate of those forces in the body by which death is resisted."—

The <u>dynamic</u> or <u>motor</u> force of the animal system, we have already seen to be in a close relation to <u>caloric</u>;—so much so as to have suggested the idea that heat and mechanic power are identical. Certain it is, that for every degree of heat, a positive and calculable result of power may be obtained.

Let me once more enumerate briefly the series of mutual effects & relations of the different forces which have been named. Thus:

Motion causes *motion*.

Friction or *percussion*, — (varieties of motion,) — will cause *heat*, — *waves of sound*, — electrical excitement, — and magnetism.

Heat causes *light*, *chemical action*, and *electric currents* or polarity.

Light causes *chemical action*, and *electricity*.

Chemical action produces *heat*, *light*, — *voltaic electricity*, and *secondary* chemical action, as fermentation for example; and fosters life-development of animal and vegetable organisms.

Electricity causes *heat*, *light*, *magnetism*, and *chemical action*, — and stimulates or generates *motor-force* in living beings.

Magnetism causes *voltaic electricity*.

Life-force maintains, directs and controls the results *of all the above* *subordinate forces*.

Motor force or dynamic power, in the locomotive apparatus of animals, stands in an evidently *direct relation to caloric*, — and in a very probable one also to galvanic electricity.

Hypothesis of *Spinal* *thermo-electric battery*, & *nervo-muscular* *electro-magnetic series*! — Bonaparte rudely guessed at this —

Thus having glanced in catalogue at the several correlations of the physical phenomena as referred to Caus~~ation~~ation, — let me now, to conclude, attempt something like a summary of results, and of ensuing inductions.

It appears to me that a close analysis will range every phase of physical causation under one or other of these heads; —

Attraction, –
Motion, —
Tendency and Polarity.

And it appears (to me) also, although time cannot be allowed (me) to defend the assertion here, – that we have not sufficient reason for acknowledging more than two attractions in nature, – that of gravitation, – or the simple and universal attraction of matter for matter, regardless of kind, — and depending

strictly on *nearness* and *quantity* for its power, — and that of chemical affinity, — or the attraction of particles of *different kinds*, — giving *atoms* a tendency to unite, which tendency *varies* indefinitely with the *substances*.

Repulsion, again, is held by many natural philosophers, very reasonably, to be always an *effect*, or secondary cause, — and never either an innate property of matter, or an active separate force. To enlarge upon or endeavor now to establish *this* position, would also require more time and attention than we have to spare. Let us, for the moment, take it for granted, and press on. It is not, in fact, *needed*, to establish the theory in question. Attraction, we have defined and limited.

Motion, we have fully discussed a few minutes since, — in its nature, — its relations to inertia, — its capability of transmission or propagation either from mass to mass or from particle to particle, — and its direct molecular effects, in the instances particularly of *Friction* and *Percussion*.

*It is a

Balance of Forces.

The forms and states of things are all dependent upon the balance of forces.

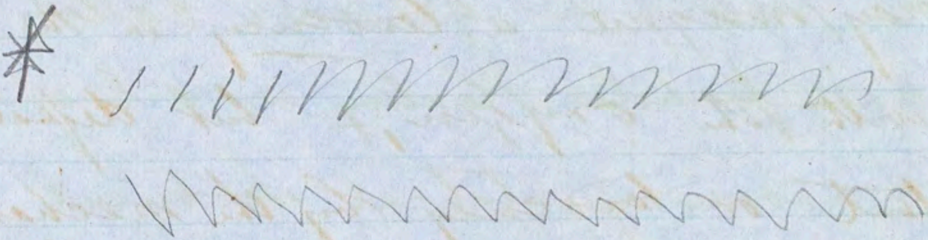
The scale-beam is Grove's illustration.

What do we mean, then, by the word *Tendency*?

It explains itself sufficiently. If illustration be needed, *pressure resisted* gives a simple one; as when I press my hand firmly upon this table, and it does not yield. We infer the tendency, from the effect produced when the resistance is withdrawn. Again, — when held over or under near — (even along side) the connecting wire of a voltaic battery, — the Compass needle displays a *tendency* to rotate around it. And the so-called two electricities, — the positive and negative excitement of the outer and inner coating of the Leyden Jar, — have a constant *tendency* to unite and produce an equilibrium. What is called *catalysis* or *predisposing affinity* may be thought to afford an instance of a similar kind, — as when water and zinc act upon each other only after the introduction to both of a suitable Sulphuric acid. There might seem to be, even, in other instances of catalysis, — examples of *defeated* tendency: as, when certain metals cause, by contact, the explosion of peroxide of hydrogen,

we may imagine a *tendency* in the metal to unite with the oxygen, — but defeated in that intent or tendency by the mechanical violence of the resulting action. These instances may serve to shew what we mean by simple *tendency*, as distinguished from motion or force in action. [redacted]

The idea of *Polarity* seems to be only a refinement upon that of tendency, with the added item of *relative position*. It is used to describe, with the least amount of superfluous meaning, those molecular changes, and ~~permanency of~~ states, in which consist many ~~classes of~~ phenomena, of electricity, magnetism, light and heat. Perhaps we may approximate to an abstract of its whole meaning, by saying, that Polarity means either motion or tendency of masses or particles, in *definite attitudes in relation to each other*. We speak of the North and South



2 a ba ba ba ba ba b

1 ab ab ab ab ab ab

poles of the earth, — and of the magnet, — and of the two poles of the galvanic battery; — and we say that particles floating in oil of turpentine, make the medium of statical electrical induction, are polarized, — when they shew a tendency to arrange themselves in lines between the charged body and that in which a charge is being induced. We then go only a little farther in saying, as most if not all electricians do, that in what is called a current of voltaic electricity in a wire, — we have really only the polarization of the particles of that wire, — successively from the positive toward, and to, the negative pole.*

What more ~~then~~ do we want, then, to account for all the physical phenomena of nature, — than the two radical laws of gravitative, and chemico-molecular, attraction, — giving impulse to infinitely diverse motions of masses and particles, — those motive impulses being sometimes accomplished & terminated in actual movements, and sometimes, under resistance,

* as well as Grove, —

Count Rumford; (1796?) "Heat is
a mode of motion."

held up, as it were, in balanced ~~statical~~ tendencies and polarities?

In this opinion, I found, — after having embraced it, that ~~I am tardy~~ ~~we are~~ I am no longer, — even in its universality of reach, alone. No less names than those of Bacon, Newton, and Sir Humphrey Davy, and, to a considerable extent, Faraday,* lend it sufficient support, by implication, — to embolden us to go ~~on~~ farther, on their own impetus, than their cautious minds would venture at once. The opinions of the French Encyclopædists, also, may be referred to as of a similar bearing. Bacon says, "Calor est motus expansivus, exhibitus, et nitens per partes minores." Heat is a motion, expansive, — ~~Thn~~ excentral, and molecular, — is my free translation. Newton is quoted by the learned Dr Young, thus; "It was his opinion that heat consisted in a minute vibratory motion of the particles of bodies, — and that this motion is communicated through an apparent vacuum by the undulations of

*See also _Grove_ upon this point : who explains the difficulty beautifully.

an elastic medium, which is also concerned in the phenomena of light." Again,—Sir Humphrey Davy, thus:—"The immediate cause, then, of the phenomenon of heat, is motion; and the laws of its communication are precisely the same as the laws of the communication of motion." I am the more satisfied in quoting these authoritative opinions in regard to heat,—since almost the only considerable difficulty the hypothesis meets with, (unless those of statical electricity), is that belonging to the subject of Latent and Specific Caloric. Yet Young himself * affords us, in the same connection, what he believed to be a sufficient solution of the difficulty, on these very points. And, having the proposition granted or asserted with regard to heat,—it must extend to light,—and we may very readily make bold also to extend it to electricity,—galvanism, magnetism,—and, more diffidently, even to life and excito-motor force. To these, I say, more diffidently. The authority of Dr Carpenter, however,—is distinctly afforded to the extension,—and, as it were unintentionally, to the very theory we

now advocate. The expression is used by him, of the "conversion of Heat & Electricity into Motion." He might readily, ~~Why did he not~~, in the inverse relation, imagine the conversion, also, of Motion into Heat, Light, Electricity &c. He speaks, ~~there~~, in another place, of Heat, Light and Chemical Affinity being transformable into Vital Force. Again, Valentin, the distinguished German authority, – upon the very first page of his admirable Text-Book, uses these words:

"Every apparatus requires a certain physical or chemical stimulus, to maintain the activity of its machinery. Thus the clock-weight conditionates the movement of the clock; – the steam that of the steam-engine, – and the combustion of its constituents, the light of the candle-wick. The like phenomenon," he continues, "recurs in living creatures." Liebig advances similar views, ~~[illegible]~~ similar language. –

But, leaving this argument, our present object being ~~rather~~ its statement than discussion, – let us behold what a simple, vast, and beautiful scheme we have, upon the theory advocated, unfolded to our view. – All things are constantly seeking an

equilibrium, as water seeks its own level. All the existing relations of things seem to depend upon a *balance of forces*, — which are but attractions in action, — resulting either in motions or tendencies. The planets, *fling forth* from the hand of God on the morning of the creation, are held in their orbits by the antagonism of the *propelling impetus*, — nothing more, — and the centripetal attraction of gravitation. Inertia is to motion as Darkness is to light; — and the Creative Spirit, moving upon the waters of a blank, inert Chaos, — when it uttered the Fiat "Let there be Light," — gave the impulse to *all* that mighty series of *material* motions, which are the pulses of Time, and the entity of Space, — which rise from the lowest starting point of gross material vibrations, to culminate at last in their acme, — Life. If, in the evening and ~~the~~ morning of the first Day, of the great first Week of the Creator's work, we may suppose the ruder motions of matter ~~in mass and in particles~~ to have been instituted, — then, with like readiness may we at least imagine,

that it was upon a radical principle of innate order that (as we find the solemn history records,) upon the last day of the same mighty septad of acts, the ~~wonderful~~ form of man having been fashioned, God breathed into his nostrils the breath of life.

For, — as a circle is mathematically known to be a polygon, — and a Sphere a polyhedron, — with an infinite number of sides, — so we may venture to conceive life-force to be but a most complex phase of ~~motion~~ movement, of infinite molecular rapidity?, and in the highest wrought, most complicated and peculiar of materials and forms.

To return. In ~~treating of~~ alluding to the magnetism of the Earth, ~~we~~ I mentioned the now generally approved theory of Biot Barlow Ampere, — ~~that~~ it depends upon an ~~voltaic~~ electric current or polarity, developed by the unequally heated condition of the earth's mass,

in its diurnal revolution, presenting different portions of its surface, in turn, to the sun; a thermo-electrical current.

May we not extend the range of this mode of causation, — upon the idea of motion, to <u>all</u> the various changes and actions which make up the phenomena of our material creation? May we not suppose, at least, — and hypothesize upon, — this extension? I find this suggestion made, — without, ~~[illegible]~~ perhaps, the same ~~[illegible] full perception~~ high estimate of its bearing, — in a very able pamphlet upon the Theory of the Forces, by my friend Dr C. ~~[illegible]~~ Cooper of this city. This writer says, — "in this way, we might refer all the phenomena of the universe, so far as we are concerned, to the simple revolution of the earth on its axis. Thus, — the same calorific action of the sun, which raises the vapor from the earth's surface, — produces the currents of the air and sea, — and these again constitute causes for other consequences, and so on throughout all nature.

See Dr Allen's very fine book upon the Philosophy of Nature. Appleton & Co.—New York, 1852.

*Or rather are diffused and transformed; — as force is never annihilated any more than matter can be.

he continues,

If, indeed," "we do pursue results to causes, — we shall find in the fact of all the phenomena of life being dependent on the motion of the earth, an argument for the supposition of the unity of the medium for the production of these phenomena." *

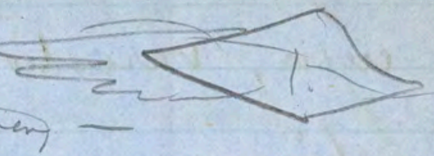
~~(that~~ Attraction, Motion, and Tendency or Polarity, ~~then~~, — (I¹ conceive², then³,) ~~all~~ hold within themselves the essence of all material causation; Drop the word Polarity, — and we have the statement in its simplest expression; attraction as the cause, — motion and tendency as the effects in one more phase of their relations, little as we can yet know of the rates of motions as to whose very existence and nature we can entertain only a daring hypothesis, — we still see a certain proportion between origin, duration and result. The simplest of relative motions, which can affect particles, — friction or percussion, — developes only the simplest effects, — heat, — electrical attraction, and perhaps light: and these are quite transitory. Easily aroused, — they readily and promptly subside*, unless maintained by ~~some~~ other superadded causation. In mechanical motion,

even, variation in the complication of machinery, — and in the apparatus for the getting up of an impetus, — to speak briefly, — is attended constantly by the same proportion in duration and other qualities of effect. The simple windlass, when you let go its handle, is at once unwound, — by direct gravitation; but the complicated clock, upon which the ingenious mechanic may ~~have~~ spent weeks, — or years, — and volumes of brain-power, in its construction, — may perform many wonders of ~~accidental~~ automatic performance, — as that of ~~striking~~ for example, and delay the period of its running down for an indefinite time.

A similar relation and proportion are observed in the more recondite molecular actions of nature. Material and form, of course, have a most important, indeed an essential influence upon these relations.

Certainly, chemical action involves a more internal and all-affecting change of

*

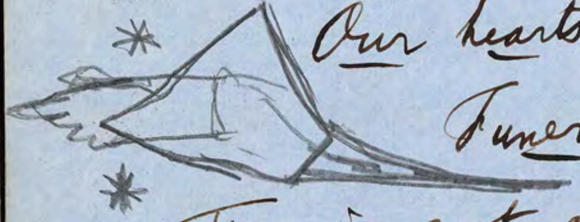


I delight to imagine, gentlemen — as one of the grandest of physical conceptions ~~that ever entered my brain~~ — the possibility of a panoramic microscope! — Conceive, if you can, — that ~~your~~ our vision could centre in the very adyta penetralia of a human body, in full life — say in the ~~solar~~ semilunar ganglion, — or on its surface. Imagine too that, looking from that point of vision, — all objects could be magnified a million times. Would anything then be at rest before your eyes? Would not each organic molecule ~~[illegible]~~ in^2 an^3 orbit^4 move^1, — obeying laws, imperative as those of Kepler, like the great ~~bodies that~~ roll through space? The laws of these motions are as beautiful, — their harmony as celestial, undoubtedly, — as those of the ~~stars~~ — (of which [illegible] ~~and that~~ each in its orbit like an angel sings) —

"Still quiring to the young-eyed Cherubim!"

particles than the mere change of place under gravitation, — or rude motion, or the mere expansion by heat: and its effects are more permanent, — its power greater, in every sense.

Passing over electricity and light, to avoid repetition and over-refinement upon a yet imperfect theoretical chaining of facts, — let us jump, at once, without fear, to the idea, that even animal life, itself, is a wound-up-force; a motion or series of motions, depending on the balance of causes or powers, — having its end in anticipation in all instances, — & coming in each case to a time when it, too, must run down.



* Our hearts, like muffled drums, are beating
Funeral marches to the grave.
*

Time is not allowed (me) to amplify upon this conclusion: confidently as a candid analysis of physiological phenomena warrants its assertion. We must only stop to say, that it does and can in no way interfere with a belief in the immortality

of the human soul. When Laplace said that he did not perceive Divinity at the end of his telescope, – he must have been blinder, mentally, – than it became so great a philosopher to be, – if, (as I doubt) he therefore dreamed of inferring that God <u>was</u> <u>not</u>. No more can any investigator of the natural history of man imagine the inference, that man's essential being cannot be unending, – because he finds no mark of immortality in the nature and laws of his <u>material</u> structure and merely animal existence. The proof is of another kind, and belongs to a~~nother~~ different sphere.

In truth, it is my belief, – that there is <u>no</u> <u>perpetuity</u> of existence, but ~~that~~ of Mind or Spirit; – of minds or Spirits, we should say; – unless, perhaps, that of essential <u>matter</u> itself, disrobed or independent of all fixed forms.

All is in change, change, change, – from the first moment when God flung forth from his right hand the moving, myriad-beinged

Universe, and saw that it was very good, — to that last coming hour, when the heavens shall be rolled together as a scroll, and put aside as a garment of which their Creator is weary.

In that hour, shall the supremacy of Mind, — even of that with which Man, in the image of his Maker, is gifted, — shine forth exalted above all the bounded and term-limited dignities of Time and Space. Then each ~~the~~ spirit ~~may I~~ say, in ~~the eloquent~~ words like those of ~~[illegible]~~ Campbell's Last man, — even to that orb whose empire over all that we know of the Universe seems now to be supreme, —

Sun, — tell the night that hides thy face
Thou saw'st the last of Adam's race
On Earth's sepulchral clod,
The darkening universe defy
To quench his Immortality, —
Or shake his trust in God!

If those who favor me with their attention will enter upon the study with the same enthusiasm, — we shall have, whatever else, the result, — at least the reward, and the dignity, of labor; as honest effort, whatever it may produce or fail to accomplish, is always honorable.

Gentlemen, — although we ~~I~~ have thus dwelt so long upon theory, — depend upon it that I shall ~~it~~ teach chiefly matters of fact. Fact and principle are what you need as medical men. It is my duty to teach the philosophy of medicine, — as founded upon a correct physiology and pathology, — and upon the relations of man to the external world: and to this object I ~~shall~~ will devote myself, — with all the energy, — and all the industry which I can command.